Improving Prediction of Extreme Precipitation Events in the Southeast US: Moisture Sources and Transport Mechanisms

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The Southeast US experiences extreme precipitation from a number of different meteorological phenomena, making quantitative precipitation forecasting (QPF) in this region especially challenging. To improve predictive capabilities in both human- and model-generated forecasts through better understanding of key moisture sources and transport mechanisms, Hydrometeorology Testbed (HMT) experiments are proposed using both observations and numerical modeling in innovative and complementary ways.

Extreme precipitation events in the Southeast US vary by (i) weather system type (e.g., organized and isolated convection, land-falling tropical systems, extratropical cyclones, orographically generated or -modulated systems), (ii) sources of moisture (e.g., Gulf of Mexico, Caribbean Sea, Atlantic Ocean), and (iii) physical processes involved in moisture transport (frontal dynamics, diabatic enhancement, direct tapping of tropical moisture); such variability further complicates the predictability of extreme precipitation events in this region.

First, observations and forecasts of historical extreme events will be used to construct climatologies of (i) observed extreme events, and (ii) the observed QPF performance associated with those events. These climatologies will then be cross-analyzed to identify atmospheric patterns associated with enhanced or diminished predictability, as well as to sub-classify extreme precipitation events and associated forecast challenges. Numerical modeling studies will be approached from two perspectives as well. Model-based case studies of extreme precipitation events will first be used for diagnostic analysis including moisture budgets and trajectory analysis. Case study model experiments such as moisture enhancement and moisture denial to key upstream regions will assist in isolating and quantifying the roles of specific features in extreme precipitation generation. In later stages of this work, modeling efforts will focus on a real-time operational forecasting framework, collaborating with the North American HMT Ensemble group and others in the NOAA testbed community to evaluate questions of predictability, model physics, resolution dependencies, and, potentially, the impacts of assimilating data collected from the HMT-Southeast Pilot Study (planned for Spring 2013). Pending support and interest, additional avenues of inter-agency collaboration to improve NOAA services are envisioned via partnerships with the Hydrometeorological Prediction Center, the Developmental Testbed Center, and with the National Severe Storms Lab/Storm Prediction Center's Hazardous Weather Testbed.

The proposed experiments will focus on improving understanding of operationally-relevant aspects of moisture sources and transport mechanisms (e.g., low-level jets, atmospheric rivers, pre-frontal warm conveyor belts) and their relationship to extreme precipitation in the Southeast US. Potential impacts of this proposed suite of tests include improved understanding of moisture sources and transport mechanisms in this region, identification of observational shortcomings and forecasting weaknesses related to extreme precipitation, and ultimately, improvements in both human- and numerical model-generated quantitative precipitation forecasts.